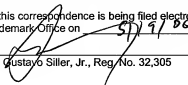


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Gustavo Siller, Jr., Reg. No. 32,305

Our Case No. 9281-4579  
Client Reference No.: N US02006

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of: Hasegawa, et al. )

Serial No.: 10/607,238 )

Filing Date: June 25, 2003 )

) Examiner: Kevin M. Bernatz

For: GMR Magnetic Detecting Element )  
Comprising Current Limiting Layer Provided )  
in Free Magnetic Layer and Method of )  
Manufacturing the Detecting Element )

) Group Art Unit No.: 1773

**AMENDMENT**

Mail Stop After Final  
Commissioner for Patents  
Washington, D.C. 22313 -1450

Dear Sir:

This amendment is in response to the Final Office Action dated March 20, 2006 in the above referenced application. Applicants respectfully request that the Examiner withdraw his objections and rejections to the claims in view of the following claim amendments and remarks.

**Amendments to the Claims** are reflected in the listing of claims which begins on page 2.

**Remarks/Arguments** begin on page 8.

**Amendments to the Claims:**

This listing of the claims will replace all prior versions and listings of claims in the application.

**Listing of Claims:**

1. (Currently amended) A magnetic detecting element comprising:

a multilayer film comprising a laminate of a free magnetic layer, a nonmagnetic material layer, a pinned magnetic layer and an antiferromagnetic layer; wherein a current flows perpendicularly to a film plane of each of the layers of the multilayer film, and the free magnetic layer comprises a plurality of soft magnetic layers which are laminated with a current limiting layer disposed therebetween, the current limiting layer comprising an insulating portion and a conductive portion;

wherein the insulating portion of the current limiting layer comprises an insulating material film having a plurality of holes extending from a top to a bottom of the current limiting layer, the holes being filled with a conductive material film serving as the conductive portion;-and

wherein the holes have an opening ratio in the current limiting layer of from about 10% to 30%, and

wherein the conductive portion of the current limiting layer comprises conductive particles, and a thickness of the current limiting layer is smaller than a particle size of the conductive particles.

2. (Currently amended) A magnetic detecting element comprising:

a multilayer film comprising an upper nonmagnetic material layer, an upper pinned magnetic layer and an upper antiferromagnetic layer, which are laminated above a free magnetic layer, and a lower nonmagnetic material layer, a lower pinned magnetic layer and a lower antiferromagnetic layer, which are laminated below the free magnetic layer;

wherein a current flows perpendicularly to a film plane of each of the layers of the multilayer film, and the free magnetic layer comprises a plurality of soft magnetic layers

which are laminated with a current limiting layer disposed therebetween, the current limiting layer comprising an insulating portion and a conductive portion;

wherein the insulating portion of the current limiting layer comprises an insulating material film having a plurality of holes extending from a top to a bottom of the current limiting layer, the holes being filled with a conductive material film serving as the conductive portion;-and

wherein the holes have an opening ratio in the current limiting layer of from about 10% to 30%, and

wherein the conductive portion of the current limiting layer comprises conductive particles, and a thickness of the current limiting layer is smaller than a particle size of the conductive particles.

3. (Previously presented) A magnetic detecting element according to claim 1 or 2, further comprising hard bias layers formed on both sides of the free magnetic layer in a track width direction, for aligning magnetization of the free magnetic layer.

4. (Previously presented) A magnetic detecting element according to claim 1 , further comprising an in-stack bias layer laminated at least one of above and below the free magnetic layer, for aligning magnetization of the free magnetic layer.

5. (Previously presented) A magnetic detecting element according to claim 1, wherein magnetizations of the plurality of soft magnetic layers are parallel to each other.

6. (Previously presented) A magnetic detecting element according to claim 5, wherein the plurality of soft magnetic layers are ferromagnetically coupled with each other through the current limiting layer.

7. (Previously presented) A magnetic detecting element according to claim 1, wherein magnetizations of the plurality of the soft magnetic layers are antiparallel to each other.

8. (Previously presented) A magnetic detecting element according to claim 1, wherein the plurality of the soft magnetic layers constituting the free magnetic layer have a same magnetic moment per unit area.

9. (Previously presented) A magnetic detecting element according to claim 1, wherein the plurality of the soft magnetic layers constituting the free magnetic layer have different magnetic moments per unit area.

10. (Previously presented) A magnetic detecting element according to claim 1, wherein the plurality of the soft magnetic layers constituting the free magnetic layer have a same thickness.

11. (Previously presented) A magnetic detecting element according to claim 1, wherein the plurality of the soft magnetic layers constituting the free magnetic layer have different thicknesses.

12. (Original) A magnetic detecting element according to claim 7, wherein the free magnetic layer comprises a nonmagnetic intermediate layer composed of at least one nonmagnetic material of Ru, Rh, Ir, Os, Re, Cr, and Cu.

13-41. (Cancelled)

42. (Previously presented) A magnetic detecting element according to claim 2, further comprising an in-stack bias layer laminated at least one of above and below the free magnetic layer, for aligning magnetization of the free magnetic layer.

43. (Cancelled)

44. (Previously presented) A magnetic detecting element according to claim 1 or 2, wherein the conductive portion of the current limiting layer comprises crystal grains and the insulating portion comprises an amorphous material.

45. (Previously presented) A magnetic detecting element according to claim 44, wherein the crystal grains comprise at least one element selected from the group consisting of Fe, Ru, Pt, Au, Rh, Ir, Pd, Os, Re, Cu, and Ag, and the amorphous material comprises an O or N compound with at least one element selected from Al, Co, Ti, Zr, Hf, Nb, Ta, Mo, W, and the rare earth elements.

46. (Currently amended) A magnetic detecting element comprising:  
a multilayer film comprising a laminate of a free magnetic layer, a nonmagnetic material layer, a pinned magnetic layer and an antiferromagnetic layer; wherein a current flows perpendicularly to a film plane of each of the layers of the multilayer film, and the free magnetic layer comprises a plurality of soft magnetic layers which are laminated with a current limiting layer disposed therebetween, the current limiting layer comprising an insulating portion and a conductive portion;  
wherein the insulating portion of the current limiting layer comprises an insulating material film having a plurality of holes extending from a top to a bottom of the current limiting layer, the holes being filled with a conductive material film serving as the conductive portion;  
wherein the holes have an opening ratio in the current limiting layer of from about 10% to 30%, and

~~A magnetic detecting element according to claim 1 or 2, wherein the free magnetic layer comprises at least three soft magnetic layers which are laminated with the current limiting layer disposed therebetween.~~

47. (Previously presented) A magnetic detecting element comprising:  
a multilayer film comprising a laminate of a free magnetic layer, a nonmagnetic material layer, a pinned magnetic layer and an antiferromagnetic layer; wherein a current flows perpendicularly to a film plane of each of the layers of the multilayer film, and the free magnetic layer comprises at least three soft magnetic layers which are laminated with a current limiting layer disposed therebetween, the current limiting layer comprising an insulating portion and a conductive portion;

wherein the insulating portion of the current limiting layer comprises an insulating material film having a plurality of holes extending from a top to a bottom of the current limiting layer, the holes being filled with a conductive material film serving as the conductive portion.

48. (Previously presented) A magnetic detecting element comprising:

a multilayer film comprising an upper nonmagnetic material layer, an upper pinned magnetic layer and an upper antiferromagnetic layer, which are laminated above a free magnetic layer, and a lower nonmagnetic material layer, a lower pinned magnetic layer and a lower antiferromagnetic layer, which are laminated below the free magnetic layer;

wherein a current flows perpendicularly to a film plane of each of the layers of the multilayer film, and the free magnetic layer comprises at least three soft magnetic layers which are laminated with a current limiting layer provided therebetween, the current limiting layer comprising an insulating portion and a conductive portion;

wherein the insulating portion of the current limiting layer comprises an insulating material film having a plurality of holes extending from a top to a bottom of the current limiting layer, the holes being filled with a conductive material film serving as the conductive portion.

49. (New) A magnetic detecting element comprising:

a multilayer film comprising an upper nonmagnetic material layer, an upper pinned magnetic layer and an upper antiferromagnetic layer, which are laminated above a free magnetic layer, and a lower nonmagnetic material layer, a lower pinned magnetic layer and a lower antiferromagnetic layer, which are laminated below the free magnetic layer;

wherein a current flows perpendicularly to a film plane of each of the layers of the multilayer film, and the free magnetic layer comprises a plurality of soft magnetic layers which are laminated with a current limiting layer disposed therebetween, the current limiting layer comprising an insulating portion and a conductive portion;

wherein the insulating portion of the current limiting layer comprises an insulating material film having a plurality of holes extending from a top to a bottom of the current

limiting layer, the holes being filled with a conductive material film serving as the conductive portion;

wherein the holes have an opening ratio in the current limiting layer of from about 10% to 30%, and

wherein the free magnetic layer comprises at least three soft magnetic layers which are laminated with the current limiting layer disposed therebetween.

## REMARKS

Claims 1-12, 42, and 44-49 are pending. Claims 24-30 and claim 43 are cancelled herein. Independent claims 1 and 2 are amended herein to include the limitations of claim 43, which is thus cancelled. Claim 46 is rewritten in independent form including all of the limitations of claim 1 prior to the present amendment. Claim 49 is new and includes all of the limitations of claim 2 and claim 46 prior to the present amendment. No new matter has been added.

### Claim Objections

Claim 43 has been cancelled, and claim 46 has been rewritten in independent form including all of the limitations of the base claim in order to overcome the objections to the claims. Applicants thus respectfully request that the Examiner withdraw the objections to claims 43 and 46.

### Claim Rejections under 35 USC §103

The Examiner asserted that claims 1, 2, 7-12, 24, 26-30, 44 and 45 are unpatentable under 35 U.S.C. 103(a) over Kamiguchi et al. (U.S. Patent 6,495,275) in view of Sugawara (U.S. Patent No. 6,828,039), Sugawara (U.S. Patent App. No. 2004/0052008 A1), and Fujiwara et al. (U.S. Patent App. No. 2002/0054461 A1).

The Examiner also asserted that Claims 3, 4, and 42 are unpatentable over Kamiguchi et al. (U.S. Patent 6,495,275) in view of Sugawara (U.S. Patent No. 6,828,039), Sugawara (U.S. Patent App. No. 2004/0052008 A1), and Fujiwara et al. (U.S. Patent App. No. 2002/0054461 A1), and further in view of Mack et al. (U.S. Patent 6,462,919).

Examiner further asserted that Claims 5 and 6 are unpatentable over Kamiguchi et al. (U.S. Patent 6,495,275) in view of Sugawara (U.S. Patent No. 6,828,039), Sugawara (U.S. Patent App. No. 2004/0052008 A1), and Fujiwara et al. (U.S. Patent App. No. 2002/0054461 A1), and further in view of Kishi et al. (U.S. Patent App. No. 2002/0191451 A1).



Applicants respectfully disagree in view of the amendments herein to independent claims 1 and 2. Claims 3-12, 42, and 44-45 depend from claim 1 or 2. (Claims 24 and 26-30 have been cancelled.)

As amended, claims 1 and 2 recite, *inter alia*, that a thickness of the current limiting layer is smaller than a particle size of the conductive particles. This limitation was originally recited in claim 43, which was found to be allowable in the prior Office action except for its dependence on a rejected base claim. Applicants therefore submit that independent claims 1 and 2 and the claims depending therefrom are allowable, and respectfully request that the Examiner withdraw the rejection of the claims under 35 U.S.C. 103(a).

### **Patentability of New Claim 49**

Claim 49 is new and includes all of the limitations of claim 2 and claim 46 prior to the present amendment. Claim 46 was found to be allowable in the prior Office action except for its dependence on a rejected base claim. Applicants therefore submit that claim 49 is patentable over the prior art of record and respectfully request allowance of this claim.


### **Allowable Subject Matter**

Applicants gratefully acknowledge the Examiner's allowance of claims 47 and 48.

### **Summary**

In view of the above amendments and remarks, Applicants respectfully submit that this application is in condition for allowance and such action is earnestly requested. If for any reason, however, the Examiner feels that a telephone interview would be helpful in resolving any remaining issues the Examiner is respectfully requested to contact Applicants' undersigned attorney.

Respectfully submitted,

  
\_\_\_\_\_  
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